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Population Aging, Mobility, and Real Estate Price: Evidence from Cities in China

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Abstract: Demographic factors are crucial to the sustainable development of one country. China's population is aging at an accelerating rate and, together with the increasing mobility between cities, some special demographic issues have formed, which is quite related to the urban real estate market. The paper aims to investigate how the population aging and mobility affect housing prices at the city level, by using a set of two-period panel data of 294 prefecture-level cities in China. The results show that an increase in elderly dependency ratio by 1% leads to a rise in housing prices by 0.368%. Meanwhile, an increase in urbanization level by 1% drives up housing prices by about 0.139%, and a rise in the ratio of inter-regional migration by 1% will increase housing prices by about 1.038%. Furthermore, the policy of purchase limits could weaken the positive impacts of elderly dependency ratio and inter-regional migration on housing prices and, thus, plays a moderating role on the relationship between demographic structure and housing prices.

Keywords: population aging; mobility; urbanization; the policy of purchase limit; housing prices

1. Introduction

Housing prices in China have been increasing rapidly especially in recent years, which has provoked widespread discussions among academics [1,2]. Demographic effects on housing prices have been verified in most studies [3]. As the fundamental factors, not only does the total population play an important role, changes in demographic structure also relate to the housing market. Generally, age structure and population mobility are the two main aspects of demographic factors, representing the age and spatial distribution of the population, respectively. Mankiw and Weil (1989) found that there was a strong connection between age and housing demand, and the baby boom in the US during the 1950s could well explain the sharp rise in housing prices during the 1970s [4]. Subsequent studies have put forward similar impacts of age structure on housing market as well [5–7]. Likewise, the impact of population mobility on housing prices has been verified in most studies as well [8–10], especially at the city level [11].

With the largest population, changes in demographic structure may cause more profound effects in China. In particular, China has implemented a birth control policy since the 1970s. As a result, the total fertility rate has kept decreasing year by year. The average total fertility rate from 1991 to 2016 is about 1.4 (the total fertility rate measures the average number of children that would be born to a woman of the 15–49. The population of the following generation will decrease once the total fertility rate is below 2), which indicates that the number of people in the next generation will decrease by over 30%. On the contrary, the percentage of the elderly population over age 65 has kept rising. It is predicted that the number of old people will exceed 300 million (nearly 20%) in 2025. At present,

the "4-2-1" family structure (the typical "4-2-1" family structure means there are four grandparents, two parents, and one child in a family. This family structure is gradually formed under the birth control policy) is very common in China. Thus, China is experiencing a very large demographic transition, and has formed special demographic issues, and has formed special demographic issues.

Researchers have discussed the issues of the increasing population aging, and formed different opinions. Some of them have particularly focused on the negative impacts. The typical "4-2-1" family structure would make young families inherit at least four houses of their grandparents, which would cause a glut of houses two decades later. Chen (2012) investigated the relationship between demographic change and housing demand using census data, and the results also expected that the growth in housing demand would drop significantly in 2012, due to the changes in age structure [12]. These researchers believed that housing prices would fall in the future due to the low fertility and the large elderly population. On the contrary, others have considered the effects of population mobility in China, which would mitigate the negative impact caused by changes in age structure [13–15]. Luo (2011) suggested that the process of urbanization would form an expectation for an increase in housing prices and, thus, generate even more housing demand [13]. Chen's (2013) study predicted that the negative impact of population aging on the housing market would not emerge until 2045 because of the positive impact of urbanization and other relevant factors [14].

These explanations do contribute to an understanding of the relationship between demographic factors and the housing market at the national level. However, the disparities in rising prices between cities are overlooked in most studies. Some cities, including Beijing, Shanghai, Guangzhou and Shenzhen, have badly experienced high housing price hikes over time, whereas there are also some so-called "ghost cities" with a large amount of surplus houses in China. Wang et al. (2017) believed that population mobility is a causal factor behind the housing price divergences among cities [11]. Recently, China's population mobility has become more and more frequent. There are at least two reasons. One is the rapid process of urbanization, in which numerous rural residents move from rural areas to urban areas [16]. The level of urbanization in China has improved from 33.35% in 1998 to 56.1% in 2015, which can definitely generate higher urban housing demand and invigorate the urban housing market. The other is the large amount of inter-regional population migration. Some people are willing to flow into the cities where more opportunities are offered, which is called labor immigration. Some people want to live in the areas with tourism resources and become tourism immigration [17]. Both the labor immigration and tourism immigration will generate great effects on housing prices. Affected by the population mobility all over the country, demographic transition becomes much more complicated at the city level.

It is necessary to investigate the relationship between demographic transitions and housing prices at city level, especially in the context of China. To maintain the sustainable development of housing market, the Chinese government has implemented a policy of purchase limits to control the precipitous rise in housing prices since the year 2010. Under the policy of purchase limits, people need quotas when purchasing houses. Although the detailed schemes of this policy are different among cities and changed with time, most of these polices are related to the local *hukou*. For example, in some cities, the residents without local *hukou* are not allowed to purchase houses, and those who have local *hukou* can only purchase one house. Thus, the policy of purchase limits is closely related to the demographic factors of one city. Taking this into account, the interaction relationship between demographic transition and housing prices at city level becomes all the more complicated and is far from certain. However, most studies focusing on relevant issues in China were conducted by national or provincial data [18,19], which definitely alleviates the differences between cities. Additionally, previous studies overlooked the effect of the policy of purchase limits when studying the relationship between demographic changes and housing prices. What effects can population aging and mobility at city level in China have on housing prices? What is the role of the policy of purchase limits? All these questions motivate our study. The following parts of the paper are organized as follows: Section 2 is a brief review of the relevant literature; Section 3 outlines the empirical model and data selected;

Section 4 presents the empirical study and its main findings; Section 5 offers a stationarity test of our results; and Section 6 provides our conclusions.

2. Literature Review

Demographic transitions have significant impacts on many economic activities, such as consumption, saving, labor supply [20,21], as well as real estate market [22–24]. The life cycle theory has established the connection between individual age and housing market, and assumes that individuals would purchase homes when they are young and sell their assets in old age in order to maintain their elderly consumptions [25]. The empirical studies have also showed that the age-specific housing demand would first rise, and then fall after a certain point [26,27]. Levin et al. (2009) employed a difference-in-difference method to examine the impacts of demographic change on house prices in England and in Scotland, and found that both population decline and population aging put downward pressure on housing prices [6]. These evidences imply that in a modern society where population aging is deepening, the increasing elderly population may become a potential crisis of a real estate market recession. However, studies on this issue have not led to a consistent conclusion. Chiuri and Jappelli (2010) pointed out that the old were less likely to sell houses before 70 years old [28]. Eichholtz and Lindenthal (2014) indicated that housing demand would decline only when individuals were at the end of their lives, and thus the aging of the population did not generate substantial decrease in housing demand [29]. Some studies have also pointed out that the housing demand of individuals will shift after retirement, and the diverse needs of the elderly population may promote real estate market to some extent [30–32].

Empirical studies based on macro-data have been conducted as well in this regard. Some scholars have analyzed how population aging affects housing prices. Takáts (2012) analyzed 22 developed economies and verified that real housing prices would be about 2/3% lower if the old age dependency ratio is 1% higher [33]. The evidences from China also show that the decline in the total population dependency ratio would promote housing prices [34], however, the impact of the elderly dependency ratio on housing prices is different from other counties. Xu et al. (2012), in the study of numerous OECD countries and China, reported that an increase in the children dependency ratio would lead to lower housing prices both in China and in the OECD counties. Yet, an increase of the elderly dependency ratio would result in higher housing prices in China, but not in the OECD countries [19]. Chen et al. (2013) established an overlapping generation model, and their empirical results by using provincial data also indicated that the children dependency ratio had a negative effect on housing prices, but the elderly dependency ratio showed the opposite effect [14]. An explanation is that old generations affected by traditional Chinese culture are willing to save money and purchase houses for their offspring, which has, to a certain extent, driven up housing prices [35,36]. Li and Shen (2013) argued that there was a nonlinear relationship between China's elderly dependency ratio and housing consumption, with the deepening of population aging, housing consumption would first increase and then decrease by the elderly dependency ratio reached a certain point, but the relationship between the elderly dependency ratio and housing prices was still unclear in their study [18].

The empirical studies of the impact of population aging on housing prices are mostly conducted at national or provincial level, as a result, the disparities of population mobility at city level are overlooked in most studies. Researchers in the developed countries have conducted a large number of studies to analyze the effects of population mobility on housing market. For example, Birrel and Healy (2008) made a comparison of the housing prices of different cities in Australia and found that population inflow was one of the main causal effects of the increasing housing price in Sydney [9]. In contrast, some studies put forward opposite evidences. Sá (2015) pointed out that migration had a negative effect on housing prices in the UK, because migration would make the local labor market more competitive and natives would move to other areas, thus resulting in a decrease in housing prices [37]. Forte et al. (2018) represented the housing condition of the immigrant population in the Southern Italy and found that as the resident immigrant population increases, there is a decrease in average housing values [38]. Due to the large amount of population mobility, Chinese scholars have conducted

many relevant studies, and most of these studies focused on the process of urbanization [39,40]. Ren and Liu (2009) found that urbanization had a positive influence on housing prices by establishing a theoretical framework and conducting an empirical study based on the provincial panel data from 1999 to 2006 in China [39]. Wang et al. (2017) pointed out that in addition to the process of urbanization, the inter-regional population inflow and outflow at city level also had a positive impact on housing prices, and an increase in inter-regional migrants by 1% would lead to a rise in housing prices by 0.701% [11]. However, studies on inter-regional population migration in China are far from enough.

Demographic structure and housing prices are both crucial to the sustainable development of one city. Governments are facing greater challenges with the rapid rise of urban population and housing prices. To maintain the urban sustainability, the policy of purchase limit was put forward in China in 2010. Chinese scholars have launched widespread discussions on this issue. Most of the studies examined the effect of the policy on housing prices and analyzed the volume-price relationship by the data of large and medium cities in China [41–43]. Zhang et al. (2015) analyzed the housing markets of 35 Chinese metropolitans under the policy of purchase limitations and suggested that strict market intervention caused significant effects on housing prices [43]. Since the policy of purchase limit may restrict the potential housing demands and not all the cities implement this policy, the impacts of demographic structure on house prices will be different among cities. However, current studies have not yet established a link between the policy of purchase limit and demographic structure.

In general, although both age structure and population mobility are important demographic factors to housing market, few studies have explored these two aspects as a whole. Specifically, research related to age structure, either established a link between individual age and housing demand, as well as asset prices from a micro perspective, or explored the impact of different age groups on house prices from the macro perspective. Research on population mobility, especially in China, focused mainly on the impact of urbanization and migration on house prices at the national or provincial level, while only a few studies paid attention to inter-regional migration among cities. Moreover, most studies in China were conducted by the provincial data, which could hardly reflect the real housing market at city level. In addition, the possible role of the policy of purchase limit in the relationship between demographic factors and real estate prices has been ignored and should be further investigated.

3. Empirical Model and Data Description

3.1. Empirical Model

Our study focuses on the impacts of the two aspects of demographic transitions, e.g., population aging and population mobility on housing prices. We use the age structure to reflect the population aging. Thus, the general empirical model is listed as Equation (1):

$$LnHP_i = \alpha + \beta_1 AgeStructure_i + \beta_2 PopMobility_i + \gamma X_{ij} + \mu \quad (1)$$

In Equation (1), housing price is the dependent variable, representing the housing price in city i. A natural logarithm form (Ln *HP*) is used to build a stable linear relationship. Independent variables are: (i) *AgeStructure*, measured by children dependency ration and elderly dependency ratio according to previous studies; (ii) *PopMobility*, including both inter-regional migration and the level of urbanization, measured by the percentage of inter-regional migrants and the percentage of non-agricultural population at city i, respectively. X_{ij} represents a series of control variables at city i. Since housing prices are affected by many different factors, some other relevant variables need to be controlled in this study. Based on the previous studies, housing prices largely depend on housing demand and supply, thus, the number of population and the disposable income that relate to housing demands are selected as the control variables [1,36,44], and the area of new built houses is also chosen to represent the urban housing supply [11,18]. In addition to the demand and supply factors, the development of cities are quite related to the urban housing prices in China [11,36]. Since the research is conducted at city level, the per capita gross domestic product and the categories

of cities (China has a tiered city system, which is categorized based on the economic development of cities. The traditional categories are "first tier cities", "second tier cities", "third tier cities", and "fourth tier cities". Thus, we use three dummy variables to measure the economic development of cities. The categories of cities in our paper are cited from the website of China's City Tier System [45].) are also added as control variables. The selected variables are listed in Table 1.

Table 1. A summary of selected variables.

	Variable	Variable Name	Proxy Variable	Data Source
Dependent variable	*Housing price*	Ln *HP*	The logarithm of housing price	China statistical yearbook for regional economy
Independent variables	*Age structure*	*CDR*	The children dependency ratio	Provincial Statistical Yearbook
		EDR	The elderly dependency ratio	
	Population mobility	*Urbanization*	The percentage of non-agricultural population	
		Inter-regional Migration	The percentage of inter-regional migrants	The sixth population census in 2010 and the provincial population sampling survey in 2015
Control variables	*Population scale*	Ln *POP*	The logarithm of the number of permanent population	China statistical yearbook for regional economy
	Income	Ln *INC*	The logarithm of per capita disposable income	
	Housing supply	Ln *HS*	The logarithm of floor space of buildings completed in construction	
	Economic development	Ln *PGDP*	The logarithm of per capita gross domestic product	
	City category	$DUMMY_F$	First tier cities (Yes = 1, No = 0)	China's city tier system
		$DUMMY_S$	Second tier cities (Yes = 1, No = 0)	
		$DUMMY_T$	Third tier cities (Yes = 1, No = 0)	

To test the role of the policy of purchase limit, two more empirical models are further conducted, see Equations (2) and (3). We assume that the policy will weaken the impacts of demographic transitions on housing prices. Here, the independent variables and control variables are still considered, meanwhile the multiplied terms $EDR_i \times PPL_i$ and $Migration_i \times PPL_i$ are included. When the policy of purchase limit and other variables X_{ij} are controlled, the coefficients β_2' and β_2'' show the moderating effect of the policy:

$$LnHP_i = \alpha' + \beta_1' EDR_i + \beta_2' EDR_i \times PPL_i + \gamma' X_{ij} + u' \quad (2)$$

$$LnHP_i = \alpha'' + \beta_1'' Migration_i + \beta_2'' Migration_i \times PPL_i + \gamma'' X_{ij} + u'' \quad (3)$$

3.2. Hypotheses

Dependency ratios in demography reflect the age structure of the population within one region. The children dependency ratio represents the burden of children on the working population. A region with more children and less adults will have a higher children dependency ratio. Since the children below 15 years old have no substantial housing demand, the higher the children dependency ratio is, the lower housing prices will be. That means an increase in the children dependency ratio leads to lower housing prices, which is also verified in the studies of Takáts (2012) [33] and Xu et al. (2012) [19]. On this basis, we further put forward the first hypothesis of our study.

Hypothesis 1. *Children dependency ratio has a negative effect on housing price.*

Population aging is one of the focuses of our research, measured by the elderly dependency ratio. The elderly dependency ratio is not only a reflection of the burden of the elderly on the working population, but also serves as an effective measure of population aging. The number of China's elderly population has been increasing as the age structure has gradually changed. Additionally, the elderly

dependency ratio at city level varies a great deal due to the inter-regional population inflow and outflow. Previous studies in China have shown that the elderly dependency ratio would have a positive effect on housing prices in China [19]. Hui et al. (2016) have pointed out that old generations in China are willing to save money and purchase houses for their children or even grandchildren [36]. We suggest another possible explanation: since urban houses were allocated before the housing system reform started in 1998, the current urban old people have almost had welfare houses without purchasing and, thus, most of the elderly population living in urban China have the abilities to purchase houses. In addition, the elderly usually have the needs of housing shift, especially after retirement, and their diverse housing demand will drive up urban housing prices. Thus, we put forward the second hypothesis.

Hypothesis 2. *Elderly dependency ratio has a positive effect on housing price.*

Urbanization level and inter-regional population migration are proxy variables with regard to population migration among cities. An increase in the level of urbanization implies more non-agricultural households, which definitely triggers higher demand for urban residential houses, thus causing housing prices to rise, as other factors remain constant. For the inter-regional population migration among cities, they have to accommodate themselves either by renting or purchasing, which will enlarge the demand of housing services and raise housing prices in the regions with more net flow population. Thus, the following two assumptions are established as follows.

Hypothesis 3. *The level of urbanization has a positive effect on housing price.*

Hypothesis 4. *Inter-regional population migration has a positive effect on housing price.*

The policy of purchase limit is put forward to restrict speculative housing demands in China. Although the policy in each city has some subtle differences, the main principles are similar. Specifically: (i) related to local *hukou*; (ii) related to the number of houses that one has held. Since most urban elderly population have already got one house through welfare allocation, it is impossible for them to purchase houses under the policy of purchase limit. As for the inter-regional migrants, some of them are non-local registered. Apparently, those with no local urban household registration have encountered even more difficulties in purchasing houses when the policy of purchase limits is implemented. Taking this policy into account, the impact of elderly dependency ratio and inter-regional population migration on housing prices will be weakened. Thus, we put forward the following two hypotheses.

Hypothesis 5. *The positive impact of elderly dependency ratio on housing price will be weakened under the policy of purchase limits.*

Hypothesis 6. *The positive impact of inter-regional population migration on housing price will be weakened under the policy of purchase limits.*

The above six hypotheses are proposed based on previous studies and the specific situation in China. A series empirical studies by using the data at city level will be conducted to test these hypotheses.

3.3. Data Description

One focus of this paper is on the population mobility among cities, but the measure of inter-regional migration is relatively difficult, especially at city level. The studies of Lu et al. (2014) [15] and Wang et al. (2017) [11] shed some light on this issue. Wang et al. (2017) have pointed out that inter-regional migration at city level can be statistically counted by the floating population from other cities which can be calculated according to the national population census and population sampling survey [11]. On this basis, the data of the national population census in 2010 and the population

sampling survey in 2015 are employed in our study, and the empirical studies are conducted by a set of two-period panel data at city level.

The sample in our study contains the current 294 prefecture-level cities in China, in which the minority autonomous prefectures are excluded (minority autonomous prefectures are minority regions, where the policies of population may be different from other regions). We collect the data of the 294 cities in the year 2010 and 2015, and the total number of samples of the two-period panel data is 588. The data of children dependency ratio, elderly dependency ratio and urbanization are collected from the Provincial Statistical Yearbook in both the year 2010 and 2015. The data of inter-regional migration are from the sixth population census in 2010 and the provincial population sampling survey in 2015. The data of housing price, housing supply, regional GDP and income are collected from "China statistical yearbook for regional economy". Our paper also focus on the effect of the policy of purchase limit, thus a dummy variable of the policy is introduced to this study. If a city has conducted any policies of purchase limit between the year 2010 and 2015, then the value of the dummy variable is 1. Otherwise, the value of the dummy variable is 0. We have searched all the official files that related to the policy of purchase limit, and find that there are 83 cities conducting the policy during the period between the year 2010 and 2015. Table 2 summarizes the descriptive statistics of the selected variables.

Table 2. A brief description of the selected variables.

Variable	Observations	Mean	Maximum	Minimum	St. Deviation
Housing Price	588	4976	33,426	1167	3493
Children dependency ratio	588	0.203	0.390	0.090	0.058
Elderly dependency ratio	588	0.175	0.393	0.033	0.051
Inter-regional migration	588	0.175	0.871	0.012	0.123
Urbanization	588	0.450	1.000	0.090	0.191
Population scale	588	434.5	3017	19.51	335.8
Income	588	22,670	52,962	10,317	7910
Per capita GDP	588	41,810	280,117	3816	29,451
Housing supply	588	828.8	13,575	2.566	1295

Notes: The units of housing price is *Yuan* per meter square; the unit of population scale is in 10 thousands; the units of per capita disposable income and per capita GDP are both *Yuan*; and the unit of floor space of buildings completed in construction (housing supply) is 10,000 m^2.

From the table above, we can see that housing prices varied a lot at city level, while the disparities of the age structure and population mobility are as large as that of housing price. Therefore, it is necessary to analyze the relationship between age structure, population mobility and housing price in detail. The next section will conduct empirical analysis to test if there are any possible correlations between them.

4. Empirical Findings

The study uses Eviews 7 to estimate the two-period panel data. The empirical results in view of Equation (1) are shown in Table 3. Estimation 1 is conducted with only the independent variables, and the result shows children dependency ratio has a negative effect on housing prices while the effect of elderly dependency ratio is positive. Meanwhile, inter-regional migration and urbanization, both have positive effects on housing prices. Estimations 2–4 are conducted with different control variables. In Estimation 2, the four independent variables and the selected control variables, *LnINC*, *LnPOP*, *LnHS*, and *LnPGDP* are included, and the adjust R^2 reaches 0.695, shows a better model fitting. Estimation 3 controls the categories of city and year and Estimation 4 contains all the selected variables.

Table 3. Empirical results.

	Estimation 1	**Estimation 2**	**Estimation 3**	**Estimation 4**
CDR	−0.453 * (−1.689)	−0.091 (−0.711)	−0.062 (−0.852)	−0.042 (−0.936)
EDR	1.824 *** (6.025)	0.323 ** (1.871)	0.323 ** (1.910)	0.308 ** (1.824)
Migration	2.282 *** (13.717)	1.077 *** (6.628)	1.149 *** (6.922)	0.748 *** (4.416)
Urbanization	0.657 *** (6.035)	0.461 *** (4.687)	0.471 *** (4.843)	0.408 *** (4.214)
Ln *INC*		0.826 *** (13.098)		0.804 *** (8.285)
Ln *POP*		0.071 *** (4.132)		0.029 (1.420)
Ln *HS*		0.016 ** (2.316)		0.016 ** (2.248)
Ln *PGDP*		0.092 *** (2.624)		0.092 ** (2.448)
$DUMMY_F$			1.016 *** (8.227)	0.673 *** (5.378)
$DUMMY_S$			0.349 *** (7.019)	0.171 *** (3.166)
$DUMMY_T$			0.128 *** (4.548)	0.022 (0.711)
YEAR			0.374 *** (12.074)	0.041 (0.895)
Constant	7.304 *** (90.709)	0.145 (0.295)	7.622 *** (10.2.28)	0.605 (0.783)
Num	588	588	588	588
R^2	0.538	0.697	0.684	0.733
Adjust R^2	0.534	0.695	0.681	0.732
F stat. of Chow tests	9.320	6.305	7.718	6.793

Notes: The dependent variable in above estimations is *LnHP*. T-statistics are shown in the brackets. ***, ** and * denote significance at the 1, 5, and 10-percent level respectively.

Estimations 2–4 all show the significant effects of elderly dependency ratio, *Migration and Urbanization* on housing prices, whereas the effect of children dependency ratio is not significant. In Estimation 4, the coefficient of elderly dependency ratio is positive, in that an increase in elderly dependency ratio by 1% leads to a rise in housing prices by 0.308% when other variables controlled. The coefficients of inter-regional migration is positive, as an increase in the percentage of inter-regional migration by 1% leads to a rise in housing prices by about 0.748% at city level. Meanwhile, the coefficients of urbanization is also significantly positive, and an increase in the level of urbanization by 1% drives up housing prices by about 0.408% at city level. Thus, Hypotheses 2, 3, and 4 can be verified from Estimation 4. However, the effect of children dependency ratio on housing price is not significant when other variables are controlled, which shows that the children dependency ratio may not have substantial impact on housing prices at city level. A possible explanation is that children live with their parents, and the amount of children can hardly generate a substantial impact on the housing market. Previous studies, such as Takáts (2012) and Xu et al. (2012), indicated the negative relationship between children dependency ratio and housing prices by using longitudinal data, which may just reflect the trend of the two variables over time. Our study, conducting by two-period panel data, exclude the possible influence of time series, which is also a promotion to the existing research.

The two-period panel data contain the data sets of 2010 and 2015. We further conduct a Chow test to test for the presence of a structural break of the two data sets. We separate the 588 samples into two

groups: one contains the samples in 2010 and the other contains the samples in 2015. Table 3 lists the F statistics of the Chow tests, and their corresponding p values are all less than 0.01, indicating that there is a structural break of the two datasets. The Chow tests suggest that there is a significant structural difference between the housing prices in 2010 and 2015, which may be related to the policy factors. The policy of purchase limit has been implemented in China since the year 2010. Our data show the scope from the year 2010 to 2015, and thus using the two-period panel data could test the moderating effect of the policy of purchase limit on housing prices at city level. Estimations 5–8 are conducted based on Equations (2) and (3), and the empirical results are shown in Table 4. Estimations 5 and 6 show the role of the policy in the impact of elderly dependency ratio on housing prices. Estimation 5 is conducted with no other variables and Estimation 6 contains all the selected variables. The results of these two estimations both show that the coefficient of elderly dependency ratio is positive, while the coefficient of *PPL*EDR* is negative, which indicates that the positive impact of elderly dependency ratio on housing prices has been weakened in the cities implemented the policy of purchase limit. In other words, the elderly population is indeed the target of the implementation of the policy of purchase limit, and the demand of the elderly to purchase another house is suppressed under the policy of purchase limits. This result suggests to us that the role of the elderly in the housing market is very important, and their purchasing power and diverse housing demand are the driving force of urban housing prices.

Table 4. Empirical results of the moderating effect of the policy of purchase limits.

	Estimation 5	**Estimation 6**	**Estimation 7**	**Estimation 8**
CDR	−0.121 (−0.527)	−0.086 (−0.412)	−0.139 (−0.602)	−0.093 (−0.442)
EDR	0.805 *** (2.858)	0.586 ** (2.216)	0.632 ** (2.247)	0.414 *** (3.607)
Migration	0.919 *** (5.498)	0.264 *** (2.503)	0.855 *** (4.185)	0.456 *** (2.818)
Urbanization	0.437 *** (4.712)	0.283 *** (3.051)	0.449 *** (4.778)	0.301 ** (3.241)
PPL*EDR	−0.695 ** (−2.835)	−0.802 ** (−2.522)		
PPL*MIG			−0.402 ** (−2.612)	−0.184 ** (−2.119)
PPL	Controlled	Controlled	Controlled	Controlled
Control variables	No	Yes	No	Yes
Constant	7.589 *** (105.62)	2.019 *** (2.659)	7.622 *** (105.37)	2.145 ** (2.816)
Num R^2 *Adjust* R^2	588 0.679 0.676	588 0.743 0.739	588 0.677 0.673	588 0.741 0.737

Notes: The dependent variable in above estimations is *LnHP*. T-statistics are shown in the brackets. ***, **, and * denote significance at the 1, 5, and 10% level, respectively.

Estimations 7 and 8 examine the moderating effect of the policy of purchase limit on inter-regional population migration. Likewise, Estimation 7 is conducted with no other variables and Estimation 8 contains all the selected variables. The results show that the coefficient of inter-regional migration is positive, while the coefficient of *PPL*MIG* is negative, which also implies that the policy of purchase limit has a negative moderating effect on the impact of inter-regional migration on housing prices. Thus, Hypothesis 6 is verified as well. A floating population with no local *hukou* is an important part of the inter-regional migrants. In the cities implementing the policy of purchase limits, these floating people are restricted in purchasing houses and, thus, their potential housing demands are limited by the government.

5. Stationary Test

To test the stationary of our results, we use the residential housing prices as the dependent variable. The results of stationary tests are listed in Table 5. The empirical results shown in ST1 and ST2 are generally consistent with the findings in Estimation 4. ST3 and ST4 are conducted based on FGLS estimated method with the same data. The results are also corresponding with the previous models. Thus, our results are robust.

Table 5. The results of stationary test.

	ST 1	ST 2	ST 3	ST 4
CDR	−0.530 ** (−1.971)	−0.015 (−0.702)	−0.498 * (−1.880)	−0.017 (−0.808)
EDR	1.833 *** (6.088)	0.286 ** (1.905)	1.890 *** (6.336)	0.288 ** (1.792)
Migration	2.224 *** (13.331)	0.751 *** (4.380)	2.078 *** (12.214)	0.749 *** (4.411)
Urbanization	0.612 *** (5.587)	0.414 *** (4.268)	0.653 *** (6.092)	0.415 *** (4.293)
Control variables	No	Yes	No	Yes
Num	588	588	588	588
R^2	0.543	0.726	0.552	0.745
Adjust R^2	0.539	0.724	0.548	0.741

Notes: The dependent variable in above estimations is the logarithm of housing price. T-statistics are shown in the brackets. ***, ** and * denote significance at the 1, 5, and 10-percent level respectively.

6. Conclusions

The relationship between demographic transition and housing prices has been studied since the 1980s. Nowadays, China has experienced noticeable demographic transition. The fertility rate has been decreasing since the 1990s due to the birth control policy, while the number of elderly people has been increasing. In addition to population aging, the two aspects of population mobility contribute to China's transformation, namely (i) rural-urban migration and (ii) inter-regional migration. Thus, it is necessary to investigate how demographic transitions influence housing prices in China. On this basis, we conduct this study by using a set of two-period panel data of 294 prefecture-level cities in China. The main findings are shown as follows: (1) an increase in elderly dependency ratio by 1% leads to a rise in housing prices by 0.308%; (2) both urbanization level and the ratio of inter-regional migration have positive impacts on urban housing prices, an increase in urbanization level by 1% drives up housing prices by about 0.408%, and a rise in the ratio of inter-regional migration by 1% will increase housing prices by about 0.748%; (3) the policy of purchase limit has a moderating effect on the relationship between demographic structure and housing prices, the positive impacts of elderly dependency ratio and inter-regional migration on housing prices have been weakened in the cities implemented the policy of purchase limit.

This paper is expected to make several contributions to the current body of literature. First, previous studies have focused either on how the change of age structure acted on housing prices [6,30,33], or on the relationship of population migration and housing prices among regions [46,47]. Yet, both aspects must be considered because age structure and population migration are closely related at city level, and the studies conducted at either national or provincial level have overlooked the disparities among cities caused by demographic transition. Our study has somehow filled the research gap, through an investigation (and analysis) of the relationship between population aging, mobility and housing prices at city level. Second, our study analyzes the relationship between the elderly population and housing price, and suggests the purchasing power and diverse housing demand of the elderly have driven up urban housing prices. Last but not least, our paper is the first of its kind to build a link between the policy of purchase limit and

demographic factors, and recognizes the moderating effect of the policy of purchase limit on housing prices, which is another contribution to knowledge in the field.

The findings in this paper provide some implications on the sustainable development of China's housing market. The rapid increase in housing prices in China has led to extensive discussions, in aspects such as insufficient land supply, irrational investment, and others. However, few studies have thus far focused on demographic factors and the relevant policies. Demographic factors are critical to the sustainable development in China. According to our findings, the distribution of population in different age groups and cities, is closely related to urban housing prices. China is rapidly becoming an aging country, and due to the birth control policies conducted since the 1970s, the current 4-2-1 family structure will significantly speed up China's population aging. Since the migrants among the cities will change the pace of aging at city level, population aging in the middle- and small-sized cities will speed up significantly and cause many social problems. To maintain urban sustainability, Chinese government should make effective policies for these cities to promote industrial upgrading and guide the distribution of migrants in an orderly manner. On the other hand, excessive housing prices will cause negative effects, and even form a crowding out effect of the population, which is not conducive to the socio-economic development. Although the policy of purchase limit indeed suppress the housing demand for some people, such as the elderly population and the inter-regional migrants verified in our study, a phenomenon cannot be overlooked is that, since the implementation of the policy of purchase limit, housing prices in most cities still keep rising, while some groups that really need to settle in cities, such as the inter-regional migrants, have no qualifications to purchase houses, which, in our view, is contrary to the original intention of the policy. The Chinese government needs to reconsider the implementation of the policy of purchase limit and figure out how to accommodate the new urban population. Furthermore, not all the inter-regional migrants would like to move into large cities, such as the tourism immigrants. Thus, the diverse demands of tourism immigrants and relevant policies should be paid more attention in the future.

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